DIELECTRIC PROPERTIES OF ALBERT COUNTY OIL SHALE

APPENDIX II. OIL SHALE BIBLIOGRAPHY

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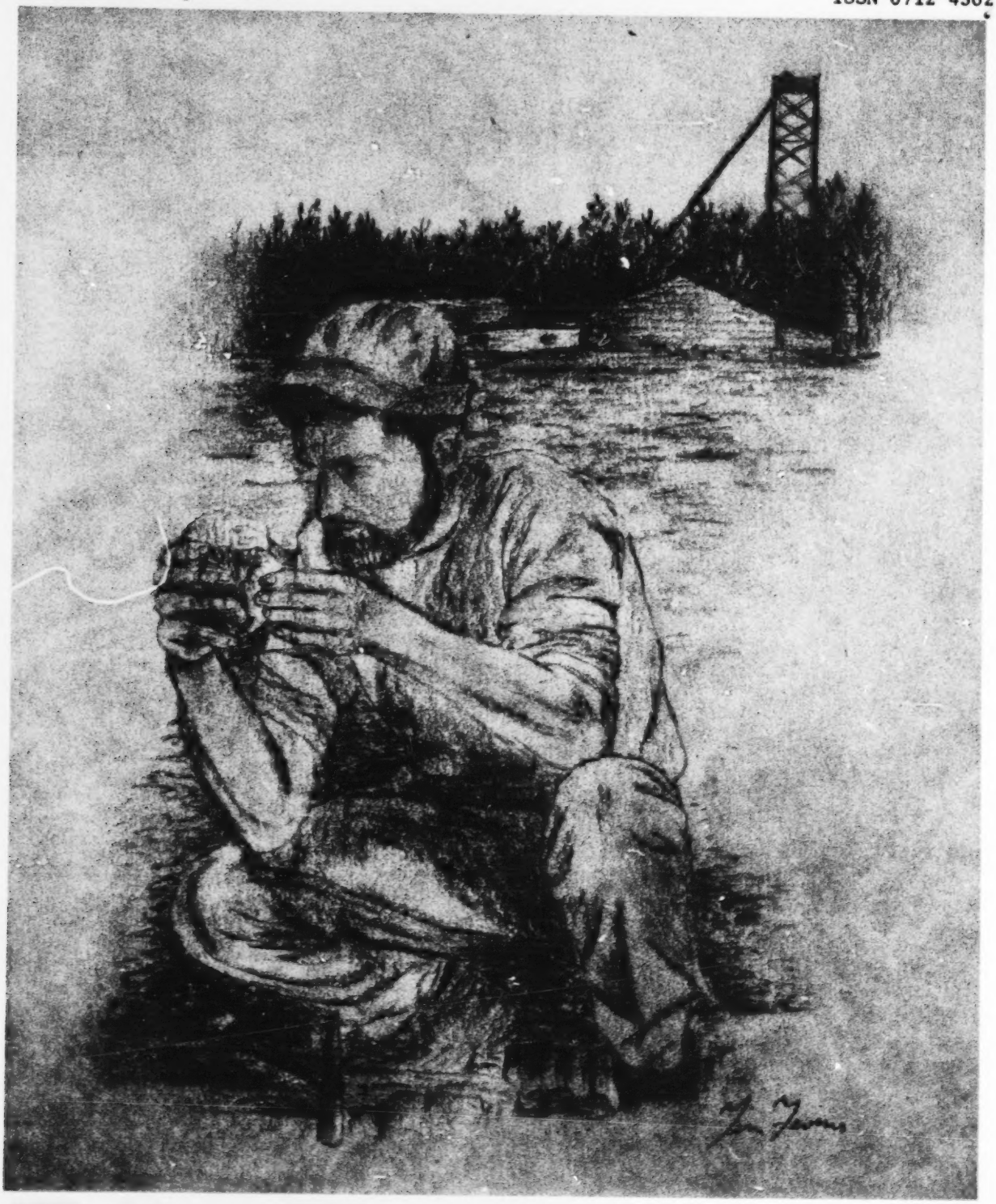

NATURAL RESOURCES
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NOUVEAU-BRUNSWICK

Government of Canada
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Mineral Resources Division
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Hon. E. G. Allen, Minister

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Mineral Resources Division
Department of Natural Resources
New Brunswick

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1. Literature Search on Oil Shales

The accompanying literature survey contains a large number of publications related to oil shale and the oil shale industry in general, as well as a section related to electrical properties of earth materials and microwave measurement techniques in particular. The latter section is of particular import in the current investigation.

In light of the manner in which the survey would likely be utilized it was subdivided into twelve major categories. Each subdivision has its titles arranged with more general ones at the beginning leading to more specific ones at the end. Abstracts of particular articles are not included as subject categories are rather clear cut and titles are, for the most part, self-explanatory. All material related to the New Brunswick oil shale areas are banded in red for quick reference. Additions to the file will be made as they become available and will be provided on completion of the next section of the study along with some literature which missed processing at the time the file was assembled. Following is a brief description of the type of literature contained in each category along with some elaboration of major topics.

1.1 General

This section contains a variety of review articles and those which examine the oil shale industry in general [1], [11]-[21]. There are general papers ([2]-[10]) on New Brunswick and Eastern Canadian resources but most are dated. Included is an Ebasco Services Inc. report [7] which discussed the feasibility of burning oil shale to generate electric power, a concept that may now be

reexamined.

The assaying of oil shale, which is central to the study of the subject, is covered in [22] - [24]. The Synthetic Fuels Data Handbook [26] contains a large volume of data compiled from several sources concerning physical properties of and experimental results on oil shale. The data is almost exclusively derived from sources in the U.S. but could be useful.

1.2 Geology

This category contains information dealing with the geology, stratigraphy, origin and classification of the different formations. References [28]-[33] deal with New Brunswick formations and again most of these are pre-1950 reports. A new study of the New Brunswick oil-bearing formation has recently been completed by Carter et al. which will update the information available from older sources. By far the greatest amount of work has been done in the U.S. and this is reflected in the large quantity of information ([34] - [58]) available for formations in Utah, Wyoming, and Colorado. This material may possibly be of some use to the geologist for comparative purposes, but is of little relevance to this study.

1.3 Electrical Properties

This section will be of greatest relevance to the current investigation. The dielectric measurement techniques being employed in this work is described in Von Hipples book, [60] but other sources [61] - [65] are available. Some ([66] - [72]) are

concerned directly with the measurement of earth material properties.

Special techniques for a similar study of Athabasca Tar Sands [62] may prove useful, however a more difficult problem with sample preparation may necessitate other measure. Due to its brittle nature shale has proven difficult to cut into regularly shaped solid fragments or regular solid shapes. Powdering the shale and reforming it in suitable shapes may prove useful but anomalies in density and elimination of the bedding plane could produce results unrepresentative of solid shale.

1.4 Physical Properties

This section contains a great deal of material which will be of importance in designing retorting conditions to optimize output. Aside from general physical properties [75] - [77] the heat capacity, thermal conductivity and decomposition temperatures [78] - [86] will be very significant parameters. Other papers [87] - [90], [92], [95] give relationships between physical properties (density, specific gravity) and oil yield for quick assay purposes. Some mechanical properties of rock are also examined [91], [94].

1.5 Coexisting Minerals

This category again contains a number of older papers [97] - [105] concerned with the New Brunswick field, the majority of which deal with the mineral albertite. Since the original vein ran out over 100 years ago no extensive deposits of albertite have been found and as a result these articles may be of only

historical interest. The remaining 32 references are concerned with the extensive mineral suite which exists in the U.S. shale deposits in Utah, Colorado, and Wyoming. Studies include economic impact analyses, thermal properties, quantitiative analysis and general studies into the nature of the deposits and their characteristics.

Parallel development of mineral resources accompanying shale oil is of primary concern. The reported existence of significant amounts of ammonium sulphate and some phosphates in Albert County shale will make this an attractive area for study. A complete study of Albert Formation minerals seems to be unavailable.

1.6 Surface Retorts

Shale retorts are of two major types, batch retorts and continuous flow retorts, the latter being the more desirable type since it avoids interrupting the process to reload. Heat for retorting may be applied directly to the retort, passed through it as a hot gas, carried in a superheated solid (e.g. ceramic balls, Tosco process) or supplied by burning of the residual carbon left after the shale has given up most of its bitumen. This latter method is the most efficient. These combustion retorts have an air stream passing over the hot shale ash, through the combustion front and on to the unretorted shale to supply it with heat. The process is analogous to inhaling air through a cigarette. When hydrogen is passed over the shale with the air the process is called hydrotorting [141]-[143].

References [144] - [155] are essentially retort descriptions and provide the details of each process. A number of articles [159] - [161], [164], [166] are concerned with retort behaviour as it relates to the size of feed aggregate. Some retorting process results [156], [159], [165] are also given.

1.7 Fracture Techniques

For purposes of in situ retorting it becomes necessary to fracture large blocks of shale [167] - [169]. This is necessary since porosity is low and the retorted oil requires cracks and spaces to seep out to the drill hole. Many different techniques are proposed [175] including nuclear explosions [170] - [174] hydraulic fracturing [176], [178], [179], ordinary explosions and electricity [177]. If fracturing is induced hydraulically then the cracks must be propped [182] to prevent collapse back to the original state once pressure is released. More violent explosive techniques avoid this requirement. It is unlikely that these techniques will be necessary in Albert County where strip mining is probably feasible.

1.8 In Situ Processes

In situ techniques possess a number of obvious advantages. It eliminates the cost of mining and would enable the exploitation of deeply buried shales. It is disadvantageous however in that it precludes development of other accompanying minerals, it is wasteful of oil shale since recovery rates tend to be very poor and it is difficult to realize due to poor porosity of oil-bearing shale units. From environmental considerations this may be the most desirable method for processing. The information contained in the reference listed under

[185] - [219] looks at many aspects of the in situ process.

1.9 Shale Oil, Refining & Fuels

Once removed from the shale bed the raw organic product (bitumen) must be processed and refined into a useable fuel. Many possibilities exist from direct production of pipeline gas [239] - [240] to making high quality jet fuel [229] - [231]. Other information in this section covers a wide scope of fuel-related topics including processing information, physical properties, products and their uses.

1.10 Waste & The Environment

Extensive work has been done on environmental impact [260] - [262]. When shale is retorted on the surface there are immense quantities of waste in the form of ash. This ash may have chemical properties that make it difficult for vegetation to reestablish itself in a dumpsite. Also rain water may leech out harmful chemicals that may have been formed in reactions which occurred at high retort temperatures and deposit them in the local watershed. Harmful effects may result in established flora and|or aquatic biota [270] - [272]. Work should not be allowed to proceed until a sound reclamation project is established to follow strip mining.

1.11 Oil Sands

A section on oil sands was included because many of the problems associated with oil sand development are common to oil shale. Some techniques for processing also show similarities. Of particular interest is the article [291] on microwave heating of tar sands. Results indicated are encouraging and show microwave crude oil to be of significantly high quality, high enough to omit entirely the first

stage of refining given conventionally extracted bitumen.

1.12 Miscellaneous

References found in this section cover a variety of subjects too numerous to detail. The material is in no specific order with exception that articles similar in nature are grouped together.

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